WIFI & ROUTE MAPPING PROJECT

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Project's goal

Mapping areas within a room or house where Wi-Fi signal strength is weak.

Summary

In this project, I created a heatmap illustrating Wi-Fi signal strength within a room. To map the walking path, I utilized measurements from the accelerometer and gyroscope sensors in a mobile phone. In the initial phase, the sensors data were processed using a Python script. The mathematical calculations to determine the walking path were performed in MATLAB. Finally, I integrated the location data with the Wi-Fi signal strength data to generate the room's heatmap.

Project's main problems

The major challenge in this project was to calculate the walking path of the user based solely on accelerometer and gyroscope sensors.

1. The sensor data was sampled at a high frequency of 500 Hz, resulting in an excess of data that slowed down the calculations.
2. The accelerometer data was not synchronized with the room's general coordinate system, during changes in walking direction.
3. High drift in position calculation occurred due to noisy accelerometer data and the challenge of distinguishing between the sensor being at rest or moving at a constant speed when the acceleration was zero.

Solution steps

Reducing the amount of data.

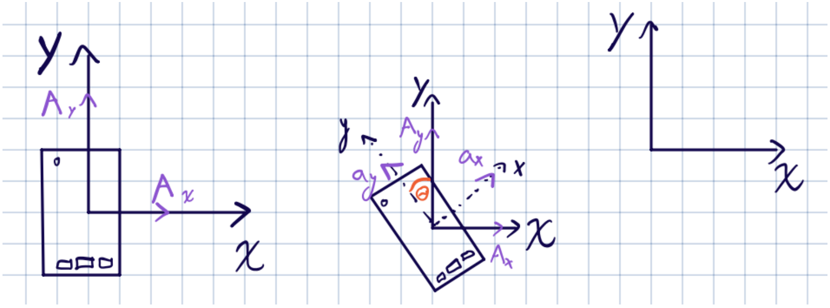
I wrote a Python script that generates a new and smaller data file, where the data is "resampled" at a frequency of 100 Hz. Reducing the sampling frequency had a negligible impact on the calculation results.

Synchronizing accelerometer data using projections onto the global coordinate system.

Using gyroscope data, I calculated the phone's angle relative to the z-axis (yaw), over time.

```
%calc angle phi over time
for i = 2:length(angle_z_gyro)
    dt = time(i)- time(i-1);
    angle_z_gyro(i) = angle_z_gyro(i-1) + wz(i) * dt;
end

%the gyro data is rad/sec - match the scale- rad to deg
angle_z_gyro = (180/pi)*angle_z_gyro;
```

Thus, at each sampling point, I calculated the accelerations in the X and Y directions relative to the room's general coordinate system.



$$A_x = -\sin(\theta)\, a_x$$

$$A_y = \cos(\theta)\, a_y$$

<u>Performing calculations for detecting movement stop (acceleration equals zero)</u>

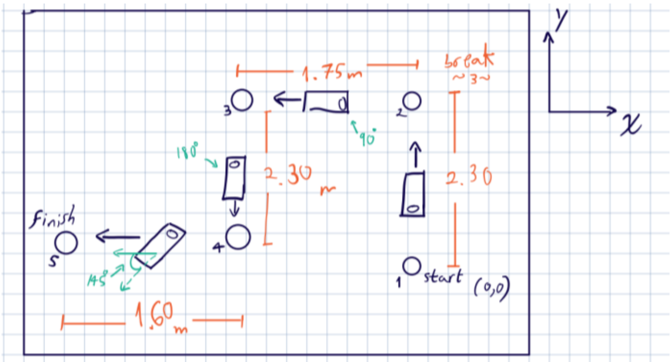
Using gyroscope data, I created conditions to check for stationary state (when small acceleration vibrations are below a certain threshold and when linear acceleration is zero). For this purpose, I created a Boolean vector `is_moving` that receives 1 during movement and 0 during stationary periods. This allowed me to define conditions for zero/constant velocity for movement in the X and Y directions.

Beforehand I applied a lowpass filter on the acceleration (cutoff frequency = 7Hz, which filters human walking pace noise).

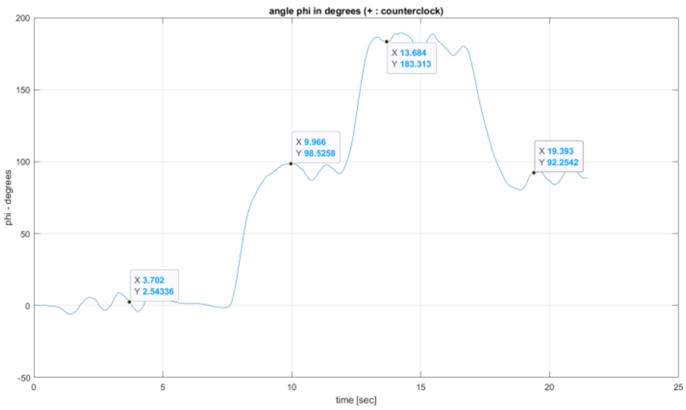
```
is_moving_y = ones(size(filtered_acceleration_y));

for i=2:length(is_moving_y)
    if abs(filtered_acceleration_y(i))<threshold && sqrt(wx(i)^2+wy(i)^2)<0.1
        is_moving_y(i)=0;
    end
    if abs(filtered_acceleration_y(i))>1.4
        is_moving_y(i)=0;
    end
end
```

Test Case

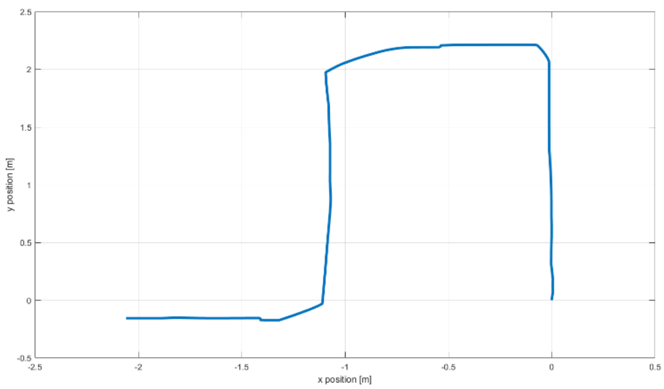
The measured walking path:



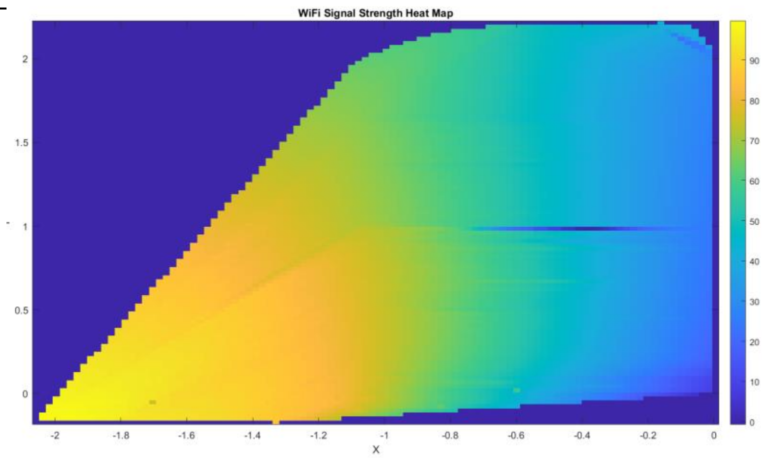
Measuring the key angle from the gyroscope sensor:



The calculated path:



HeatMap of wifi signal:



HeatMap of wifi signal: